

SIMULATING LANDFILL BIODEGRADATION PROCESSES WITH T2LBM

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RESEARCH OBJECTIVES

We have developed T2LBM, a module for the TOUGH2 simulator that implements a Landfill Bioreactor Model. This model can simulate processes of aerobic or anaerobic biodegradation of municipal solid waste (MSW) and the associated flow and transport of gas and liquid. We present an example study to verify the code against a laboratory experiment carried out in a parallel effort. The overall objective of our MSW landfill research is to investigate the advantages and disadvantages of different landfill treatment approaches.

APPROACH

We have enhanced an existing numerical reservoir simulator to include additional chemical components and biodegradation processes relevant to MSW. Our approach assumes that a single substrate component (acetic acid, CH_3COOH) serves as a proxy for all of the biodegradable fractions in MSW. T2LBM includes six chemical components (H_2O , CH_3COOH , CO_2 , CH_4 , O_2 , N_2) and heat distributed in gaseous and aqueous phases with partitioning by Henry's law. This approach further assumes, implicitly, that hydrolysis reactions occur to produce acetic acid. Gas and liquid containing the chemical components flow through the MSW refuse mass as governed by Darcy's law. The focus of the process model is on biodegradation with nonisothermal effects and the associated gas production, along with liquid- and gas-phase flow through the refuse mass.

ACCOMPLISHMENTS

We have carried out tests of T2LBM and compared results against published studies of biodegradation. In addition, we have compared T2LBM results to the laboratory experiment of MSW biodegradation carried out in parallel with model development. Shown in Figure 1 are the volume fractions of oxygen (O_2) from the experiment and from a T2LBM simulation over a 40-day period. The event being examined is a respiration test in a system where air is blown into the MSW for 28 days to keep it aerobic, and then (for a short period) the air is turned off and the system is shut in. Over the period of shut in, we can observe the rate of O_2 consumption, i.e., respiration. During the shut-in period, the O_2 was rapidly consumed, and the system became anaerobic. At $t = 31$ days, the fan was turned back on, air addition continued, and the system became aerobic

again. As shown in Figure 1, T2LBM was able to match the observed O_2 volume fraction data fairly well, using kinetic biodegradation parameters from the literature. We also plot the T2LBM CO_2 curve to show its relation to the transition from aerobic to anaerobic conditions.

SIGNIFICANCE OF FINDINGS

Our preliminary testing of T2LBM suggests that the simulator is capable of modeling fundamental aspects of MSW biodegradation processes. Further development and testing are needed to elucidate the capabilities and limitations of the model for simulating laboratory experiments and actual MSW landfills.

RELATED PUBLICATION

Oldenburg C.M., T2LBM: Landfill Bioreactor Model for TOUGH2, Version 1.0. Berkeley Lab Report LBNL-47961, 2001.

ACKNOWLEDGMENTS

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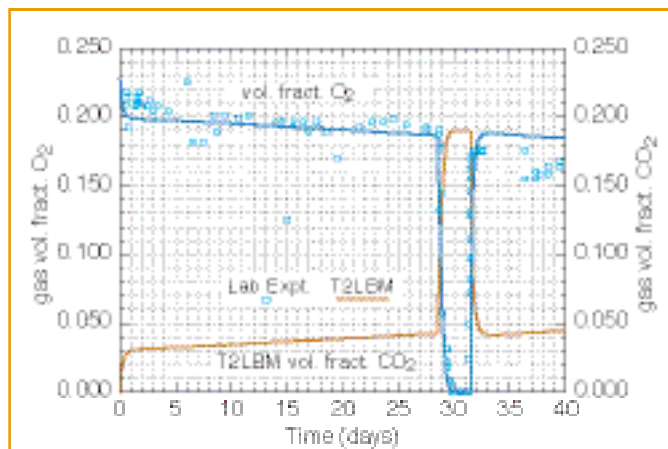


Figure 1. Volume fractions of O_2 from the laboratory experiment and from T2LBM plotted along with volume fraction of CO_2 from T2LBM